Program Agenda

- Spatial Vector Acceleration
- In Memory PointInPolygon
- 3D Geodetic Support
- Newest Network Graph Functionality
  - Multi Modal
  - Traffic Patterns
- Newest GeoRaster Functionality
  - In Database Raster Algebra
  - Physical and Virtual Mosaic
  - New GUI For Loading and Unloading Rasters
- Newest Fusion Middleware MapViewer
Oracle 12c
Much Faster Spatial Algorithms
SPATIAL_VECTOR_ACCELERATION
Oracle 12c Initialization Parameter

- **New faster algorithms** for spatial operators and functions (up to 350x)
- Metadata caching increases performance:
  - For all spatial operators and functions
  - For all DML operations (INSERT, UPDATE, DELETE)
- Recommended for any application with mission critical spatial query performance requirements.
- Requires Oracle Spatial and Graph License
  - `ALTER SYSTEM SET SPATIAL_VECTOR_ACCELERATION = TRUE`
  - `ALTER SESSION SET SPATIAL_VECTOR_ACCELERATION = TRUE`
New
In Memory Point In Polygon Function
SDO_PointInPolygon
New In memory point in polygon operation

- Parallel Enabled
  - Argument 1 – SQL statement (cursor) that defines which points (x,y) to process
  - Argument 2 – Polygon
  - Returns all points inside polygon

- Can “serially” process more than 70,000 points per second
- Multiply by number of cores for potential throughput “per second”

- NO SPATIAL INDEX REQUIRED
New - 3D Geodetic Support
Oracle 12c - 3D Geodetic Support

- DISTANCE, ANYINTERACT and INSIDE operations take height into account
- LRS functions also support 3D geodetic data
Oracle 12c - 3D Distance Calculation For Geodesic Segment

Length of geodetic segment whose endpoints have different heights

- Endpoint with greatest height (P1) is projected onto the sphere of (P2) … and (P3) is generated.
- The distance between P2 and P3 is spherical
- The distance of P1 to P2 is calculated as the length of side (P1,P2) of triangle (P1,P2,P3).
Oracle Spatial and Graph
Network Graph
New Features
Network Graph Concepts
Why Drive Time Analysis Is Important

- Reachability given a constraint (time or distance) should consider a road network.
- “As the crow flies” computations can be misleading.
- For example, they may cross rivers where there are no bridges.
Spatial Analysis Versus Network Analysis

- Oracle Locator and Oracle Spatial solve spatial proximity problems.
- Another type of analysis that is required by users and applications is network analysis.
- Network applications deal with the connectivity of features. Spatial data is optional.

Spatial Closest feature (based on distance) Verses Network Closest feature (based on connectivity and cost)
What Is Oracle Spatial & Graph Network Graph?

- An open data model to store and analyze network data.
- Connectivity is determined using nodes and links:
  - Each link has a start node and an end node.
  - Links and/or nodes can have costs
  - Links can be one way or bi-directed
What Is Oracle Spatial & Graph Network Graph?

- Analysis is based on connectivity and optionally cost information.
- Network analyses includes:
  - Shortest path analysis
  - Nearest neighbor analysis
  - Within cost analysis
  - Minimum cost spanning tree
  - Traveling salesman problem
  - Reachable/Reaching nodes
  - K-shortest paths analysis
Network Graph Demo

• Demo available on OTN Spatial Page
Network Constraint Example

Customize Oracle’s Algorithms

```java
public class NoHighwayConstraint implements LODNetworkConstraint {
    public NoHighwayConstraint(){}

    public boolean isSatisfied(LODAnalysisInfo info) {
        LogicalLink link = info.getNextLink();
        if (link==null || link.getLevel() == 1 )
            return true;
        else
            return false;
    }
}
```
Feature Modeling/Analysis

Model networks with application features instead of nodes and links

- Data model to manage node and link “features” with their associated “network elements”
  - Node features: transformers, sub-stations, etc.
  - Link features: power lines, transit routes, etc.
- Consistency between network features and network elements automatically maintained
- Feature level analysis
  - Find the shortest path between two transformers
  - Find the shortest path between two transformers, but use only a certain wire type
Oracle Spatial and Graph - Network Data Model
Best Route Using Traffic Pattern Information

Temporal Modeling/Analysis

- **Traffic Patterns**
  - Record historical travel patterns for different classes of roads
  - Data collected based on time of day and day of the week

- **Use traffic patterns to compute shortest paths**
  - Find shortest path from point A to B with start time of 8 AM
  - Find shortest path from point A to B and reach destination at 5.30PM

- **Support NAVTEQ Traffic Patterns format out of the box**
Multi-Modal Routing

- Each mode (car, bus, rail, bike, etc) modeled as a separate network
- Single logical network represents all modes of transportation
- Transition nodes where networks meet
- NDM APIs can specify the modes to consider
- Out of the box support for transit data published by transit authorities
  - GTFS (General Transit Feed Spec) supported
Parallel Enabled Geocoding
Oracle Spatial & Graph - Geocoder

- Geocoder is included in your Oracle Spatial and Graph license.
- Open data model for Geocoder reference data
- If you have reference data, you can populate the data model yourself
- If you don’t have the reference data, Oracle Partners sell it in Transportable Tablespace format (plug and play data).
  - HERE
  - Tom Tom
  - ADCI
  - others
Oracle Spatial and Graph Geocoder

- Forward / Reverse / Street Centerline / Rooftop (point based) support

- **In database geocoding** –
  - PL/SQL APIs
  - Optimal for parallel enabled batch geocoding
  - For batch processing, leverage parallel enabled pipeline table functions

- **Web service based geocoding**
  - Java servlet based with XML geocoding APIs
  - Deployed in J2EE container
  - Optimal for non-batch request in web based applications.
  - Can perform batch processing too
Geocode Times On Exadata X4-2 1/2 RAC

- X4-2 with 96 cores
- Geocoded 77216 addresses in 3.32 seconds
- **23,257 geocodes per second**
- Works on commodity hardware too
Geocode Result

- Result returns both:
  - Percent (between 0 and 1) and Edge ID. In this example (.12, 23612131)
  - Longitude, Latitude

- For customer use case on next slide, want (Percent, Edge ID)

```sql
SDO_GEO_ADDR(0, SDO_KEYWORDARRAY(), NULL, 'New Montgomery St', NULL, NULL, 'SAN FRANCISCO', 'SAN FRANCISCO', 'CA', 'US', '94105', NULL, '94105', NULL, '33', 'NEW MONTGOMERY', 'ST', 'F', 'F', NULL, NULL, 'R', .12, 23612131, '??X?#ENUT?B281CP?', 1, 'DEFAULT', -122.40158, 37.78835, '??010101010??000?', 8307)
```
Customer Use Case

Oracle Spatial and Graph
Geocoder and Network Graph
Marketing Requirement
Road Network, Stores, and Customers

- Store locations in red
- Street network for the US in black
- E-mail fliers to millions of customers from their closest store.
More Than One Way To Solve

But not all approaches are optimal

- As the crow flies computations often assign wrong store to a customer.
- Given 1,000,000 customers, and 100 stores, compute drive time every combination? Takes a very long time.
- Voronoi Diagrams to group customers and stores and reduce drive time computations.
- Preprocessing may take days.
THINK OUT OF THE BOX
For millions of customers, find closest store within a specified drive time

- Same underlying data for geocoder and road network
- Customers geocode as link id and percentage (instead of longitude/latitude)
- 5 mile Network Buffer generates all possible paths
- Each persisted path includes:
  - Covered link IDs, nodes ID, and associated costs
- Single database query to find closest store and drive time/distance for each customer (join on link_id)

-20 minute Reverse Network Buffer computed in approximately 3 seconds
Newest Oracle Spatial and Graph GeoRaster Features and Functionality
Raster Concepts
What Is Raster Data?

- Raster data is spatial data that is created by assigning values to a matrix of cells that cover objects.

Coarser resolution

Finer resolution
A Raster Is A Matrix Of Numbers

Value Attribute Table

<table>
<thead>
<tr>
<th>Cell Value</th>
<th>Geological Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Quaternary</td>
</tr>
<tr>
<td>2</td>
<td>Tertiary</td>
</tr>
<tr>
<td>3</td>
<td>Mesozoic</td>
</tr>
<tr>
<td>4</td>
<td>Proterozoic</td>
</tr>
<tr>
<td>5</td>
<td>Archaean</td>
</tr>
<tr>
<td>6</td>
<td>Gondwana</td>
</tr>
</tbody>
</table>

Matrix of raster cells (or pixels)

<p>| | | | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
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<th></th>
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</tr>
</thead>
<tbody>
<tr>
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<td>3</td>
<td>5</td>
<td>5</td>
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</tr>
</tbody>
</table>
MultiBand Digital Image: Example

- Each band is collected at a different wavelength for later processing and display.
Blocking Raster Data

- One image can be Gigabytes in size
- Index very large rasters into smaller blocks
- Generate pyramids

<table>
<thead>
<tr>
<th>Raster ID</th>
<th>Block ID</th>
<th>BLOB</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td><img src="image1" alt="Raster 1" /></td>
</tr>
<tr>
<td>1</td>
<td>2</td>
<td><img src="image2" alt="Raster 2" /></td>
</tr>
<tr>
<td>1</td>
<td>3</td>
<td><img src="image3" alt="Raster 3" /></td>
</tr>
<tr>
<td>1</td>
<td>4</td>
<td><img src="image4" alt="Raster 4" /></td>
</tr>
</tbody>
</table>
New - In Database Raster Algebra
New Raster Algebra and Analytics Engine

- Four Map Algebra cell value based functions:
  - Conditional queries - Searches/masks cells based on booleanExpr
  - Updates - Update cells of a raster-based on booleanExpr
  - Arithmetic operations - ADD, DIVIDE, LOG, etc.
  - Classification for raster segmentation - Applies arithmetic expression to cells and then segments the raster based on the expression result
In Database Raster Algebra

- Algebraic functions applied to derive new results
  - Generate new raster layer from two or more raster layers
  - Raster algebra operations implement sophisticated analytical algorithms
    - Normalized Difference Vegetation Index (NDVI)
    - TCT (Tasseled Cap Transformation)
    - You can define your own
  - NDVI helps classify the amount of vegetation in a region, from none to rainforest
- Parallel Enabled Raster Algebra - Optimized for parallel hardware architectures
Oracle Spatial and Graph GeoRaster
Physical and Virtual Mosaic
Mosaic of Landsat Images

- 454 source images
- Each about 400 Mb
- Total about 108 Gb
- About 30% overlap
- Images span many UTM coordinate systems
Newest Mosaic Functionality

Physical and Virtual Mosaic Support

- Mosaic can be persisted (physical), or virtual (on the fly)
- Rasters can be different coordinate systems and resolution (resampling)
- Pyramids can be mosaiced
- Virtual mosaic defined by a SQL statement or a table column
- User defined priority for overlapping regions (Date or SQL ORDER BY)
Newest Mosaic Functionality

- Supports gaps, no data, and overlapping regions
- More advanced mosaic support:
  - georeferenced raw images
  - internal reproject/rectification
  - common point rules (max value, min value, etc...)
  - large-scale image append
Newest Mosaic Functionality

- Supports gaps, no data, and overlapping regions
- More advanced mosaic support:
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  - large-scale image append
Oracle Spatial and Graph GeoRaster Mosaic Demo
Demo - Landsat 5 TM Images

Physical Mosaic – Persist result

- 454 source images, each with 7 bands
- Each about 400 Mb
- Total about 108 Gb (with pyramids 143 Gb)
- About 30% overlap for each image
- Images span many UTM coordinate system
- Parallel 8 – Three hours to mosaic
Demo - Mosaic of Landsat Images

Physical Mosaic – Persist Results

- 454 source images
- Each about 400 Mb
- Total about 108 Gb
- About 30% overlap
- Images span many UTM coordinate systems
- Parallel 8 – Three hours to generate
Demo - Landsat 5 TM Images

Virtual Mosaic

- Mosaic on the fly
- Transform UTM coordinate systems on the fly
- No additional storage
- Mosaic pyramids on the fly too
Oracle Fusion Middleware MapViewer
New HTML5 API
Oracle Fusion Middleware MapViewer

- Web Map Server
  - Bundled feature of Oracle Fusion Middleware and Oracle WebLogic
- Easily publishes data stored in Oracle’s native spatial data types to the web
- Provides the following API’s:
  - XML
  - Java
  - OGC Web Map Service
  - HTML5 API – Fully disconnected capability
Oracle MapViewer – Publish Maps To The Web

NEW – 11.1.1.7
Web Based Editor

Thematic Map

Themes

Legend

Footnote

Earthquakes

Avg household income per block group & Past earthquakes
MapViewer with JDeveloper And OBIEE

Oracle JDeveloper

Oracle BI EE
Oracle Fusion Middleware
MapViewer Demo
Q&A
Oracle BI SampleApp V406
(Includes MapViewer HTML5 Samples)